

THE ANNUAL COSTS OF HOSPITAL SPACES AND MEDICAL EQUIPMENT

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Abstract

Tampere University of Technology (TUT), Institute of Construction Economics and Management carried out a research program on the operating costs of hospital spaces and medical equipment. In the program, computer aided cost calculation methods for hospital technology were developed in co-operation with Finnish hospitals. The objective of the research projects from 1992-1994 was to develop hospital space models for a computer aided expert system for budgeting and estimating construction costs and operations and maintenance (O&M) expenditures of buildings. The cost models were attached to the Building Cost Information System and to the computer programme WinTaku. The main objective of the research in 1995 was to create a uniform space coding system and a calculation method for internal rents. The coding system and the calculation method are applicable to all hospitals in Finland. The objective of the research from 1996-1998 was to define the capital costs and O&M expenditures of hospital equipment, and to develop a calculation method for the annual operating costs of medical devices and technical systems.

Keywords: hospital, space, medical equipment, life time, utilisation, costs, expenditures

1 Introduction

The development of medical technology and the purchase of new equipment often cause alterations in hospital spaces. When the medical equipment are selected, normally the investment costs are recognised. The costs of space alterations and the operations and maintenance expenditures of technology are not fully understood. Yet, all the technology costs should be known to ensure the economical resources during the whole useful life time of spaces and equipment.

The problem is, that the investment budgets and the estimates of annual operations and maintenance expenditures of technology need to be fixed at a very early stage of a project, even before any preliminary designs are done. Formulation of reliable estimates, based on a list of required spaces, is difficult. Therefore, a system was developed regarding the cost planning and the subsequent cost control for construction projects (Haahtela & Kiiras 1980).

Haahtela & Kiiras published the Building Cost Information Manual in Finland in 1980. The manual included the methods to formulate guiding budgets at planning stage with 500 space cost models, and an elemental method to estimate costs, for construction and rehabilitation projects. A computer program WinTaku, based on the manual, was developed in 1990 by Haahtela-kehitys Ltd.



The estimation method for operations and maintenance (O&M) expenditures of buildings was developed in 1993. The system is updated annually by Haahtela-kehitytys Ltd..

From 1992-1994, Tampere University of Technology (TUT), Institute of Construction Economics and Management carried out two research projects in co-operation with Finnish hospitals and Haahtela-kehitytys Ltd. As a result, the construction and the O&M cost models for **50 hospital spaces** were attached to the Building Cost Information Manual and the WinTaku Program.

From the beginning of 1996, the prices of health care services in Finland had to comprise all operations, space and equipment costs. In the internal invoicing of institutions, the capital and the operating costs of spaces and medical technology are included in the internal rents charged from the user departments. One of the problems, in the internal invoicing of space rents, was the fact, that the construction and maintenance costs have not been focused on individual spaces or even on individual buildings. Another problem was the diversity of hospital space records and the various coding systems used in the records. The main objective of the research project in 1995, was to create a computer aided calculation method, with which the rental values for hospital spaces can be calculated.

In the beginning of 1996, TUT started a research project, in which the capital costs and the O&M expenditures of medical equipment were defined. The main objective of the project was to develop a computer-aided method for calculation of the operating costs of medical equipment for their whole useful life time. The phases of the research program are shown in Figure 1.

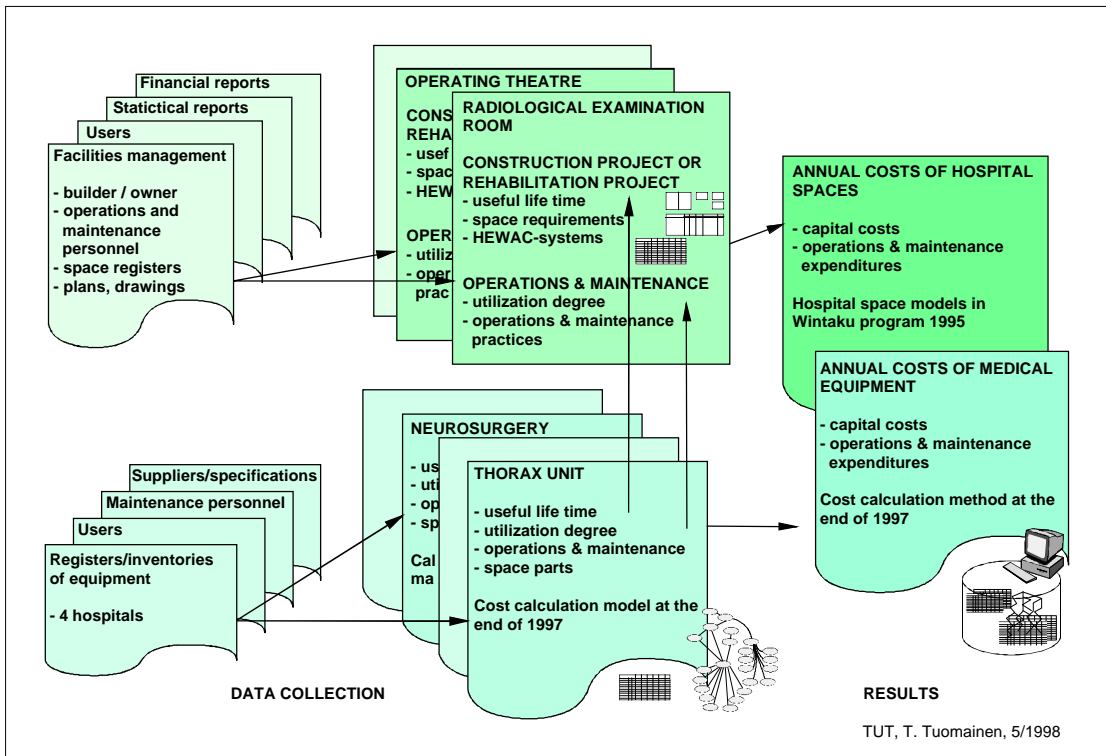
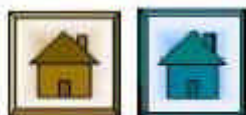


Fig. 1. The components of the research program at TUT during the years 1992-1998.

The annual operating costs of hospital buildings can be calculated with 550 space cost models, and the costs of medical technology can be calculated with 21 equipment composition models.



2 Construction and operating costs of hospital spaces

The objective of the research project was to develop hospital space models for the Building Cost Information Manual and the WinTaku Program. Fifty spaces from surgical, radiotherapy, laboratory, intensive care, first-aid and technical departments were selected, the requirements of which differed from the existing models in the budgeting system. The impact of the spaces on the total costs of the construction project is remarkable because of the high spatial prerequisites.

The space requirements and services systems of hospital spaces were studied regarding construction and operating costs. The data was collected from the completed spaces, work drawings and specifications. The users, designers and experts were interviewed. The developed hospital space models were attached to the WinTaku Program and tested by computing the costs of six hospitals. The computed construction and O&M costs were compared with actual costs, and the models were modified.

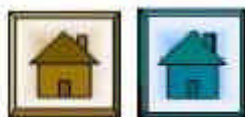
2.1 The construction costs of spaces

The construction costs of spaces are caused by performance requirements and system solutions. The spatial calculation models in the WinTaku Program include over 100 alternative parameters and system solutions, which the client or the user of the space can define. Figure 2 shows a construction cost calculation model of a radiological examination room.

ROOM REQUIREMENTS		
Radiological examination room	12 300 FIM/m2	280 RC/m2
1 SIZE AND SHAPE		7 FURNITURE, EQUIPMENT 469 FIM/m2
Size of the room	35 m2	Working desk 4 m
Dimensions	6,2 * 5,6 m2	Selves m
Special floor structures	FIM/m2	Cupboards 2 pc
Height of the floor	3,6 m	Fixed chairs pc
Height of the room	3,3 m	Window supplies winm2/m2
Span	7,2 m	Equipment FIM/m2
2 INTERNAL CLIMATE		8 PARTITIONS INSIDE
Temperature	>+ 22 C	Partitions in the room m2
Thermal load	120 W/m2	Doors in the room pc
Air intake	6 l/sm2	Laminated partitions m2
Speed of air intake	normal	Folding doors m2
Exhaust	3,6 l/sm2	Glass partitions m2
Heat recovery	100 %	Lifting curtain m2
Local air exhaust	pc	Lifting curtain 27dB m2
Humidity	humidity controlled	Portable wall 48dB m2
Ventilation holes	% of floor space	
3 SOUND INSULATION		9 LOAD, DURABILITY, SAFETY
Partition walls	40 dB	Load 5 kN/m2
Doors	dB	Bridge crane kN
4 LIGHTING		Durability of walls, doors high requirements
Need of windows	m2	Fire class of the doors 15 min
Windows in many sides	%	Fire class of the structures 60 min
Need of rooftop	m2	
Need of glass partitions	m2	10 CONNECTIONS
Lighting	15 W/m2	Door to other rooms 1 pc
5 HVAC-EQUIPMENT		Doors out pc
Taps, basins, showers	1 pc	Folding door to other rooms m2
WC-seats, sewerage	pc	Folding doors out m2
Pneumatic supplies	3 pc	Flexibility of partitions 100 %
Gas supplies	5 pc	Need of circulation room 62 %
Req. for clean gas	100 %	Need of technical room 26 %
Sprinkler	%	Balconies m2
Need for flexibility	%	Courtyard 1 m2/ grm2
Other HVAC-supplies	FIM/m2	Asphalt 50 %
6 ELECTRICAL EQUIPMENT		Drainage 10 courtm2/grating tank
Sockets	28 pc	External equipment FIM/grm2
Watts	2000 W/m2	External structures FIM/grm2
Telephone sockets	1 pc	
Flexibility	100 %	11 FINISHES 1400 FIM/m2
Door light	pc	Wall finishes 360 FIM/m2
Electr. sockets for PC	pc	Ceilings 40 FIM/m2
Data sockets	1 pc	Floor finishes 500 FIM/m2
Other electrical supplies	1772 FIM/m2	

WinTaku program Haahtela-kehitys Ltd

Fig. 2. The construction cost model of a radiological examination room. The costs of hospital construction and rehabilitation projects can be calculated with 550 space models in WinTaku Program. 1 FIM = app. 0,18 USD.



2.2 The annual operations and maintenance (O&M) expenditures of spaces

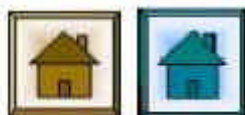
The annual operations and maintenance (O&M) expenditures of spaces are caused by operational requirements and the degree of utilisation. The spatial calculation models in the WinTaku Program include 18 parameters with alternatives, which the client or the user of the space can define. Figure 3 shows an annual O&M cost model of a radiological examination room.

OPERATIONS AND MAINTENANCE EXPENDITURES OF SPACE								
Radiological examination room		12300 FIM/m ²		280 RC/m ²				
O&M		Total	Heating energy	Electric power	Water and waste water	Cleaning	Maintena	Other costs
Expenditures	FIM/m ² /year	490	65	196	5	154	70	
Percentage of user								
Use of space	%	100	100			4	4	
Availability of space	days/year	365	365					
	hours/day	10	10					
Room temperature	°C	23	23			+24...26, exclusive		
General lighting	%	100	100			14	hours/day	
Personal lighting	%						hours/day	
Consumption of electric power, occupant p %		7	7			4900 W	usually less than 10%	
Consumption of electric power, continuous %							W usually less than 10%	
Utilization of waste heat	%	100	100					
Consumption of water	%	1	1			36 l/d	usually 0,5...4%	
Cleaning	d	1	1			2,6h/m ² /year		
Furniture % of floor space	%	10	10				usually less than 40%	
Extras for cleaning	%	130	130				Compared to office level	
Maintenance	FIM/m ² /month	5	5				With office level	
Waste	l/day	15	15					
Use of local air exhaust	%							
Internal air transfer	%							

WinTaku program Haahetela-kehitys Ltd

Fig. 3. The operations and maintenance (O&M) cost model of a radiological examination room. The annual O&M costs of hospital buildings can be calculated with 550 space models in WinTaku Program.

After the research projects, the costs of hospital construction and rehabilitation, and the annual O&M costs of hospital buildings can be calculated with 550 space models in the WinTaku Program. The results of the studies indicated that the calculation method, and the space models can be applied to the formulation of the guiding budgets for the hospitals, if certain prerequisites are considered. The study also gave information on the requirements that should be included in the system and the program, since the special conditions of hospital operations has to be looked upon, when the budgets are made.



3 Space classification and internal rents of hospitals

The main objective of the research project was to create a record with eighty hospital spaces. The second objective was to describe the functions and performance requirements of the spaces, on the basis of which the hospitals' existing space records could be modified. The third objective was to define the capital, operations and maintenance costs, and to develop a method for the computation of the internal rents of hospital spaces. The results of the previous research projects were regarded viable for the space classification of hospitals, and for the definition of the internal rents. The spaces were grouped according to the Building-90 (Talo-90) standard and coded according to the Building Cost Information System.

The changes in the health care building stock in Finland were surveyed over the past forty years. As a result, a recommendation for the depreciation and the rate of interest to be used in the calculation of capital values of hospital buildings was made. A computer aided calculation method was developed, with which the rental values for eighty hospital space models can be calculated.

4 Annual operating costs of medical equipment

TUT carried out the research project on medical equipment from 1996-1998. The objective was to define the capital costs and operations and maintenance (O&M) expenditures of medical equipment. The second objective was to develop a calculation method for the annual operating costs of medical devices and technical systems.

Some Finnish hospitals have over ten years statistics on the life times, the investment costs and the O&M expenditures of their medical equipment. Research data for radiological examination equipment and spaces was collected from the University Hospitals in Helsinki and Tampere and the Health Care Districts in Central-Finland and Northern-Karelia. The nursing and maintenance personnel and the equipment suppliers were interviewed concerning the use and the perceptions of the devices development. The investments, the O&M expenditures and the number of examinations during the years 1992-1995 for more than 100 radiological examination equipment were studied in four Finnish hospitals. The pilot calculation model was developed for the capital costs and operating expenditures of twelve radiological examination rooms. Figure 4 shows the cost comparison of a Computed Tomography Unit.

ANNUAL COSTS OF MEDICAL TECHNOLOGY															
										Current Price	5 000 000 FIM				
										Price Adjustment Index	131.30 Medical Equipment (1980=100)				
										Consumer Price Index	113.90 (1990=100) for O&M				
										Electric Power	0.3 FIM/kWh				
										Water	FIM/cum				
										Helium	FIM/litre				
Sheet Techcost .xls										Open Register	Return				
Project Costs of CT unit										Delete Line	Graph				
Code	Equipment	Number of Equipment	Interest Rate, %	Useful Life, years	Operating Time, days/week	Operating Time, hours/day	Duty Hours, hours/week	Degree of Utilization, %	Equipment Costs, FIM/year (Current Price+O&M average)	Equipment Costs, FIM/year (Actual Invest+O&M average)	Equipment Costs, FIM/year (Actual Invest+O&M maxim)	Space sqm	Space Costs FIM/year	Equipment Costs + Space Costs (Current Price) FIM/year	Equipment Costs + Space Costs (Average) FIM/year
SFS 401060	Computed Tomography	1	5	5	8	20	36%		1 609 100	1 647 200	2 965 100	40	60 000	1 609 100	1 707 200
SFS 401060	Computed Tomography	1	5	5	7	8	20	45%	1 609 900	1 648 000	2 965 900			1 609 900	1 648 000
SFS 401060	Computed Tomography	1	5	10	7	8	20	45%	1 102 600	1 124 000	2 166 400			1 102 600	1 124 000
SFS 401060	Computed Tomography	1	5	10	5	8	24%		1 100 700	1 122 000	2 164 500			1 100 700	1 122 000
SFS 401060	Computed Tomography	1	10	5	8	24%			953 100	969 600	1 932 000			953 100	969 600
SFS 401060	Computed Tomography	1	10	5	8	24%			951 000	967 500	1 929 900			951 000	967 500
SFS 401060	Computed Tomography	1	10	5	8	24%			500 000	516 500	787 900			500 000	516 500
SFS 401060	Computed Tomography	1	10	5	8	24%			500 000					500 000	

TUT, T. Tuomainen 5/1998

Fig. 4. The cost comparison of a Computed Tomography Unit.



The second phase of the research was launched in March 1997. The information on the purchase prices and years, life times, and maintenance expenses of the equipment of the different types of operating theatres were gathered from the hospital registers. The information on the operations expenses was collected from the suppliers' specifications. The operating times and the utilisation degrees of the surgical equipment were defined by interviewing the users. The calculation methods and the data for seven operation room equipment compositions were attached to the cost calculation model. The calculation method can be used in conjunction with the WinTaku Program for estimation of operating costs of hospital technology.

The costs of spaces and medical technology per operation can also be shown graphically. Figure 5 shows the costs of a Computed Tomography Unit per medical operation.

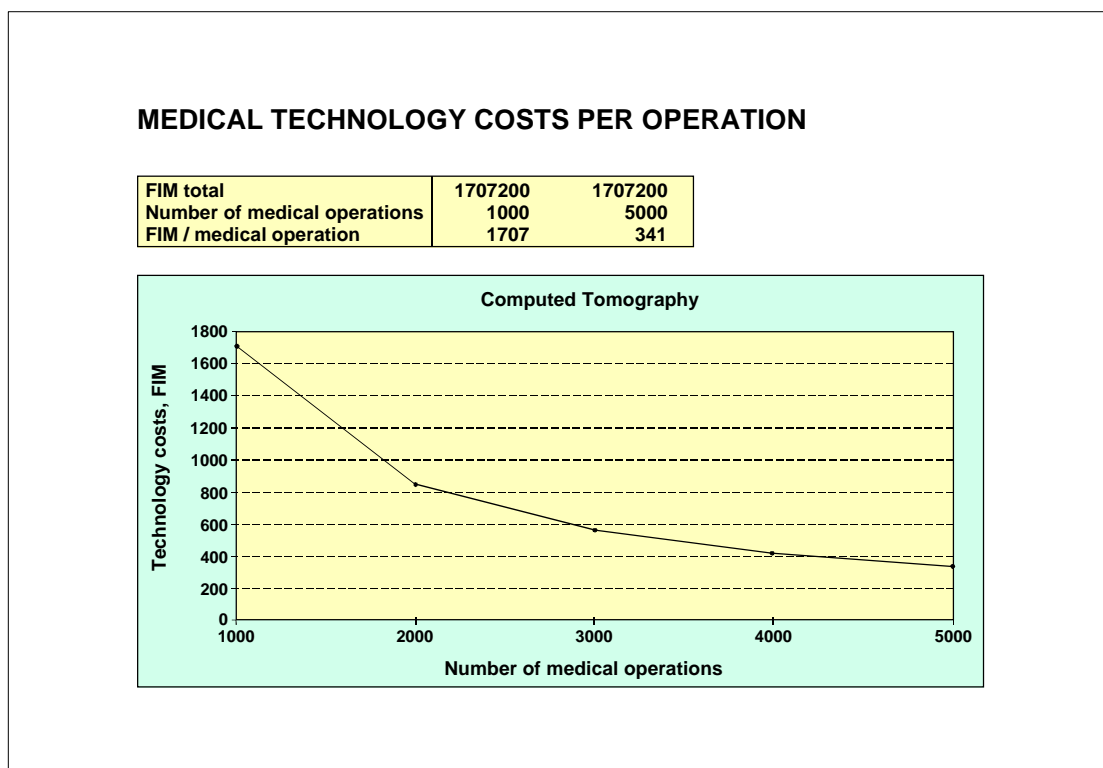
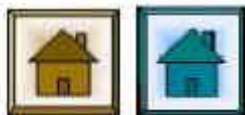


Fig. 5. The technical costs per medical operation of a Computed Tomography Unit.
1 FIM = app. 0,18 USD.

5 Concluding remarks

The aim of the research program on hospital space costs and equipment expenditures, was to develop methods for the hospital facility management to serve more efficiently the needs of the users and the owners of the hospitals. With the developed equipment and space cost calculation methods, the effects of technology investments on hospital budgets, can be analysed at a preliminary planning stage. Additionally, the data, which was collected in the research program, can be used for determining the economical life times of hospital equipment and spaces.



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